REMARKS

Applicant would like to thank the Examiner for the careful consideration given the present application. The application has been carefully reviewed in light of the Office action, and amended as necessary to more clearly and particularly describe the subject matter which applicant regards as the invention.

The Examiner has rejected claims 1-7 under 35 U.S.C. 103(a) as being unpatentable over U.S. Pat. Pub. No. 2003/0018283 to Dariush in view of U.S. Pat. No. 6,289,265 to Takenaka. The Examiner's rejections are traversed for the following reasons.

The present application relates to a method of estimating a joint moment of a bipedal walking body. The method includes a first step for sequentially grasping the displacement amounts of a plurality of joints, including at least an ankle joint, a hip joint and a knee joint of each leg of a bipedal walking body, and a second step for sequentially grasping the positions and/or postures of corresponding rigid bodies of the bipedal walking body that are associated with rigid elements of a rigid link model using at least the rigid link model. The rigid link model is established beforehand to express the bipedal walking body in the form of a link assembly composed of a plurality of the rigid elements and a plurality of joint elements and the grasped displacement amounts of the joints. The method further includes a third step for grasping the acceleration of a preset reference point of the bipedal walking body by using at least an output of an acceleration sensor attached to a predetermined region of the bipedal walking body, and a fourth step for sequentially grasping a floor reaction force acting on each leg and the position of an acting point of the floor

reaction force. The grasped positions and/or the postures of the corresponding rigid bodies of the bipedal walking body, the floor reaction force and the position of the acting point of the floor reaction force being changeable every moment, the acceleration of the reference point, the floor reaction force, and the position of the acting point of the floor reaction force are used to estimate a joint moment acting on at least one joint of each leg. At least the displacement amounts of the hip joint, the knee joint, and the ankle joint of each leg that are grasped in the first step include the amount of rotation about an axis substantially perpendicular to a leg plane as a plane passing through these three joints. A posture of a leg coordinate system which is fixedly set to the leg plane is changeable with respect to a body coordinate system which is fixedly set to the bipedal walking body. The displacement amount of the hip joint is a three-dimensional amount, and the positions and/or postures of the corresponding rigid bodies grasped in the second step include at least the positions and/or the postures of the corresponding rigid bodies of the leg on the leg plane, the acceleration of the reference point grasped in the third step and the floor reaction force and the position of the acting point of the floor reaction force grasped in the fourth step are three-dimensional amounts. A component of a joint moment acting on at least one joint of the leg about the axis that is substantially perpendicular to the leg plane is estimated on the basis of an inverse dynamic model representing the relationship between the motions of the corresponding rigid bodies of the leg and the translational forces and the moments acting on the corresponding rigid bodies on the leg plane by using the two-dimensional amounts obtained by projecting at least the acceleration of the reference point, the floor reaction force, and the position of the acting point of the floor reaction force onto a

leg plane related to the leg on the basis of a displacement amount of the hip joint of the leg, and the positions and/or the postures of the corresponding rigid bodies of the leg on the leg plane.

Dariush relates to a feedback estimation of joint forces and joint moments. In particular, Dariush includes an upper body portion (105) and a lower body portion (110). The lower body portion (110) includes an ankle joint (120), a knee joint (125), and a hip joint (130). A "forward dynamics module determines kinematics through numerical integration (or simulation) of the dynamic equations of motion" (Para. [0011]). Further, "joint loads are recursively estimated for a planar serial link system" (Para. [0012]).

Takenaka involves a controller for a legged mobile robot. In particular, Takenaka relates "to a posture control system of a legged mobile robot, and more specifically a system for conducting a compliance control on the motion of the legs of a legged mobile robot, in particular a biped robot, and controls the floor reaction force acting on the robot appropriately" (Col. 1, lines 7-12).

Claim 1 of the present application recites "a second step for ***sequentially*** grasping the positions and/or postures of corresponding rigid bodies of the bipedal walking body that are associated with rigid elements of a rigid link model using at least the rigid link model". In support of this rejection, the Examiner points to Fig. 2 of Dariush, which is shown below.

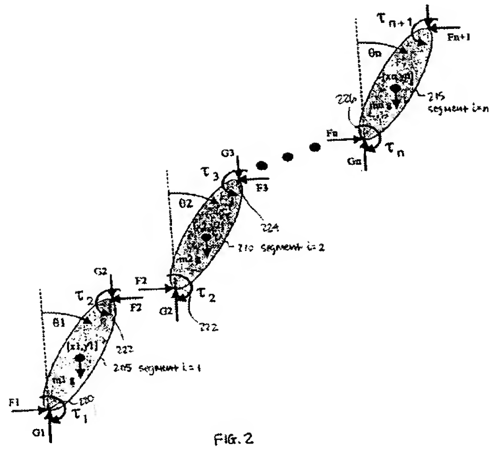
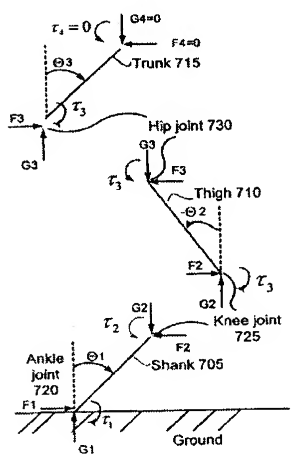


FIG. 2

Review of Fig. 2 fails to teach or suggest that there is ***sequential*** grasping of the positions of the rigid bodies. Rather, Fig. 2 merely shows free body diagrams of the segments (Para. [0018]). There is no indication in Fig. 2 that the positions are sequentially grasped. Therefore, Dariush cannot be cited for teaching or suggesting the required "second step for sequentially grasping the positions and/or postures of corresponding rigid bodies". Removal of the rejection of claim 1, and claims 2-7 that depend therefrom, is respectfully requested.

Amended claim 1 of the present application also recites that "at least the displacement amounts of the hip joint, the knee joint, and the ankle joint of each leg that are grasped in the first step include the amount of rotation about an axis substantially perpendicular to a leg plane as a plane passing through these three joints, a posture of a leg coordinate system which is fixedly set to the leg plane is changeable with respect to a body coordinate system which is fixedly set to the bipedal walking body". In support of this rejection, the Examiner points to Para. [0094] and Figs. 5 and 7 of Dariush. However, review of the cited section and figures fails to teach or suggest this step. In Para. [0094] of Dariush teaches that "tracking system performance is examined for two cases: when the acceleration

estimates are included (a=1 in FIG. 5), and when the acceleration estimated are ignored (a=0 in FIG. 5)". Dariush further teaches that the "analytically computed ground reaction vector $U_1=[F_1\ \ G_1\ \ \tau_1]^T$ is obtained using the recursion equations starting from trunk 715 and working toward the ground" (Para. [0094]). Fig. 5 is merely a block diagram for the error correction controller (Para. [0021]). For convenience, Fig. 7 is shown below.



Examination of Fig. 7 fails to reveal that there is a plane that passes through the hip joint, the knee joint, and the ankle joint. Instead, the hip joint, knee joint, and ankle joint are each in a different plane. Further, inspection of Fig. 1 of Dariush also fails to show that the hip, knee, and ankle joints share a common plane. As such, the amount of rotation about an axis substantially perpendicular to a leg plane as a plane passing through these three joints could not be grasped. Accordingly, removal of the rejection of claim 1, and claims 2-7 that depend therefrom is requested.

Claim 1 of the present application also recites that "the displacement amount of the hip joint is a three-dimensional amount". However, review of Dariush fails to teach this feature. For reference, Fig. 3 of Dariush is shown below.

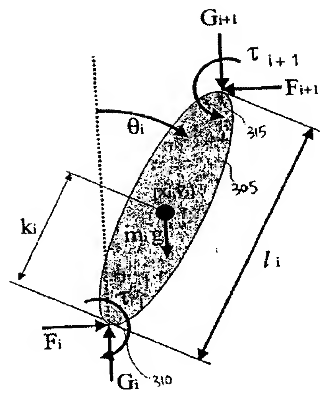


FIG. 3

As discussed in Para. [0048] of Dariush, the joint angle (Θ_i) of the body segment (i) is scalar (e.g. a one dimensional amount), as opposed to a three-dimensional amount as recited in claim 1 of the present application. Therefore, the rejection of claim 1, and claims 2-7 that depend therefrom should be removed.

Claim 1 of the present application also recites that "the acceleration of the reference point grasped in the third step and the floor reaction force and the position of the acting point of the floor reaction force grasped in the fourth step are three-dimensional amounts". As described in Paras. [0047-0048] and Figs. 1-3 of Dariush, the ground reaction force (115) acting on the first segment (205) is a two-dimensional amount only having a horizontal direction component (x direction component) (F_1) and a vertical direction component (y direction component) (G_1), and the position of the acting point of the reaction force (115) i.e. the position of the joint 1 (310) of the first segment (305) is a one-dimensional amount only having an x direction component. Therefore, Dariush also fails to teach or suggest these three dimensional amounts. Accordingly, removal of the rejection of claim 1, and claims 2-7 that depend therefrom is requested.

Claim 1 of the present application further recites that

> "a component of a joint moment acting on at least one joint of the leg about the axis that is substantially perpendicular to the leg plane is estimated on the basis of an inverse dynamic model representing the relationship between the motions of the corresponding rigid bodies of the leg and the translational forces and the moments acting on the corresponding rigid bodies on the leg plane by using the two-dimensional amounts obtained by projecting at least the acceleration of the reference point, the floor reaction force, and the position of the acting point of the floor reaction force onto a leg plane related to the leg on the basis of a displacement amount of the hip joint of the leg, and the positions and/or the postures of the corresponding rigid bodies of the leg on the leg plane".

Examination of Dariush fails to teach or suggest estimating a moment based upon motion of the corresponding rigid body. Rather, Dariush uses a recursive process that estimates moment based upon motion of the preceding rigid body (Para. [0047]). For this further reason, the rejection of claim 1, and claims 2-7 that depend therefrom, should be removed.

Finally, it is noted that the Examiner has cited to Takenaka to address the lack of a teaching in Dariush of grasping acceleration. However, Takenaka does not correct the deficiencies of Dariush. More specifically, Takenaka concerns an entirely different concept and does not conduct any estimation as recited in claim 1 of the present application. Therefore, even if the references were combined, they would still be deficient. Thus, the Examiner has failed to provide a *prima facie* case of obviousness of claim 1, from which claims 2-7 depend. Therefore, the rejection of claims 2-7 must be withdrawn.

In light of the foregoing, it is respectfully submitted that the present application is in a condition for allowance and notice to that effect is hereby requested. If it is determined that the application is not in a condition for allowance, the Examiner is invited to initiate a telephone interview with the undersigned attorney to expedite

prosecution of the present application.

If there are any additional fees resulting from this communication, please charge same to our Deposit Account No. 18-0160, our Order No. SAT-16451.

Respectfully submitted,

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